Anthropogenic $^{129}$I has been released to the environment in different ways and chemical species by human nuclear activities since the 1940s. These sources provide ideal tools to trace the dispersion of volatile pollutants in the atmosphere. Snow and seawater samples collected in Bellingshausen, Amundsen, and Ross Seas in Antarctica in 2011 were analyzed for $^{129}$I and $^{127}$I, including organic forms; it was observed that $^{129}$I/$^{127}$I atomic ratios in the Antarctic surface seawater ($6.1-13 \times 10^{-12}$) are about 2 orders of magnitude lower than those in the Antarctic snow ($6.8-9.5 \times 10^{-10}$), but 4-6 times higher than the prenuclear level ($1.5 \times 10^{-12}$), indicating a predominantly anthropogenic source of $^{129}$I in the Antarctic environment. The $^{129}$I level in snow in Antarctica is 2-4 orders of magnitude lower than that in the Northern Hemisphere, but is not significantly higher than that observed in other sites in the Southern Hemisphere. This feature indicates that $^{129}$I in Antarctic snow mainly originates from atmospheric nuclear weapons testing from 1945 to 1980; resuspension and re-emission of the fallout $^{129}$I in the Southern Hemisphere maintains the $^{129}$I level in the Antarctic atmosphere. $^{129}$I directly released to the atmosphere and re-emitted marine discharged $^{129}$I from reprocessing plants in Europe might not significantly disperse to Antarctica.